



PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Commutator Carbon Brush and Method of its Manufacture

We, SIGRI ELEKTROGRAPHIT GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, a German Company, of Werner-von-Siemens-Strasse 18, Meitingen über Augsburg, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a commutator brush of carbon, such as those made of industrial carbon or electro-graphite, having a high ratio of transverse resistance to longitudinal resistance, and to a method of producing the same.

A highest feasible transverse resistance of commutator brushes is desirable for securing a satisfactory commutation performance, particularly in alternating-current commutator machines operating with high commutator lamination or sector voltages. Electrographite brushes, however, as a rule, only exhibit a transverse to longitudinal resistance ratio of no more than 1.1:1 to 1.3:1. For example, an electro-graphite brush, on the average, has a longitudinal resistivity of about 40 ohm mm²/m and a transverse resistivity of about 52 ohm mm²/m.

Brushes made of natural graphite show an improvement, with a ratio of transverse resistivity to longitudinal resistivity of 4:1 to 6:1 being obtained. Brushes of natural graphite however, have the disadvantage of only withstanding relatively low current loads. Modern motors, for example traction motors, operating with high current densities amounting on the average to 10-12 Amp/cm² and with peak loads of 20-22 Amp/cm², thus call for the use of electro-graphite brushes because of their much higher current-carrying capacity.

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It has previously been attempted to produce electrographite brushes with a higher ratio of transverse to longitudinal resistivity using so-called layer-type brushes or sandwich brushes. These are composed of several individual layers extending transverse to the longitudinal direction and being cemented together. By employing an insulating cement, the longitudinal resistivity of such brushes can be kept unchanged while the transverse resistivity is considerably increased. The drawback of this type of brushes, however, resides in the fact that the cement masses are not able to withstand the high mechanical, electrical and thermal stresses occurring in the running surface of the brush. At this surface there occur high temperatures partly due to arcs and partly due to transient high contact resistances, and these high temperatures overstress the insulating mass composed essentially of different kinds of synthetic resinous plastics. As a result, the brushes lack sufficient mechanical stability in continuous operation and suffer from reduced transverse resistivity at the running surface due to formation of conducting coke bridges. Such brushes, therefore, still leave much to be desired.

It is further known to subdivide brushes twice or three times, using a twin or triplet brush instead of a single homogeneous block-type brush. It has been found, however, that in practice such brushes are subjected to non-uniformities with respect to current distribution.

Recently there have been developed methods which afford the production of carbon fibers by carbonization of natural fibers and which also permit the production of mesh material or woven fabrics of carbon by carbonization of natural-fiber fabrics

Such carbon fibers or webs can be graphitized and thus be converted to graphite fibers or graphite woven webs. Fibers and webs of this kind have very high electrical resistivities. Their electrical resistance is greatly dependent upon orientation; the resistance in the fiber direction being considerably lower than transversely thereof. It is also known to compress several layers of the graphite web while applying a carbonizable binding agent, and to convert the resulting body to coke or subsequently to graphite. The artificial bodies of carbon or graphite are applicable for a variety of purposes, including commutator brushes. The current-carrying capacity of such brushes, however, is lower than that of the conventional electrographite brushes.

It is an object of this invention to devise a commutator brush having a high ratio of transverse to longitudinal resistance but avoiding the above-mentioned disadvantages of the brushes heretofore available.

According to the invention, a commutator brush, generally of the above-described type, is provided with one or more layers of mesh material formed of carbonized fiber which is embedded within the bulk material of which the body of the brush is otherwise constituted, the mesh layer extending longitudinally of the brush body and preferably consisting of a web or woven fabric made originally from animal fiber such as wool.

A brush structure thus composed is illustrated by way of example on the accompanying drawing which schematically shows a longitudinal cross section.

The body 1 of the brush consists essentially of industrial carbon which need not be different from that employed for conventional brushes. Embedded within the body of carbon and integrally bonded therewith are two woven web layers 2 and 3 consisting of carbonized fiber which may be graphitized. The two layers are parallel to each other. The spacing between them is approximately equal to the spacing of each from the nearest longitudinal side of the brush body, although it will be understood that other distance relations are applicable and that a larger or smaller number of embedded mesh layers may be provided.

A brush as exemplified by the above-described embodiment is made by pressing the green mass of bulk material in a die or other mold in the conventional manner but placing the web layers of carbonized fiber into the green mass so that upon completion of the pressing operation the inserted web material is either located in the middle of the pressing height or, as shown on the drawing, has approximately the position indicated. In this manner, the brush body being molded and pressed may be provided

with two or more inserted webs of woven carbonaceous material.

The pressing operation forces the particles of the green mass into the mesh openings of the web of carbonized fiber. Thus the green mass enters into an intimate and fast bond with the web. Since the individual threads of carbon or graphite have a porous structure, a further anchoring in the brush body is achieved by virtue of the fact that binding agents, contained in the green mass, will penetrate into the threads of the web material and become bonded thereto. For these reasons, the subsequent carbonization as well as any subsequently applied graphitization, results in a uniform body with a homogeneous bonding of the embedded webs. The bonding can be further improved by moistening or impregnating the webs with binding agent prior to embedding the webs in the green mass. The binding agent, for example, may be applied as a spray of tar, synthetic resin or the like plastics material. Moistening of the carbon or graphite webs with furfuryl alcohol prior to embedment is particularly recommended.

After coking (carbonizing), the brush bodies with the embedded web layers and, if desired, after subsequent graphitizing treatment, the resulting commutator brushes possess the desired anisotropic specific electrical resistivity. The attainable ratio of transverse to longitudinal resistivity is about 6:1 or more.

Brushes according to the invention have the further advantage of excellent running qualities. This is due to the fact that the carbon or graphite fibers of the embedded web are of the same kind as the bulk material of the brush body, and for that reason are no cause of trouble. The absence of inhomogeneities leads to an absence of vibration or rattling.

It has been found preferable to employ embedded webs of fabrics produced by carbonization of animal fibers, for example wool.

The embedding of a web of carbonized fiber into the brush body may also be effected by inserting into the green mass a web that is not yet completely carbonized, especially a web of animal fiber material, whereafter the conventional carbonizing and, if desired, graphitizing operation is performed. When thus employing an incompletely carbonized web layer, the subsequent carbonization of the shaped brush body causes cracking, and the evolving reaction products improve the bonding between the webs and the bulk material.

The invention will be further described with reference to examples.

EXAMPLE 1

The green mixture is prepared from

carbon black obtained by mixing carbon black with a binder to form pasty bodies in the form of modules which are then coked and comminuted coke powder and tar-pitch binder. When ready for pressing, the mixture is filled into a mold of 100 mm by 150 mm cross section, up to a height of 30 mm, and the top is smoothed to planar shape. Then a roughly woven mesh of carbonized fiber, of 0.7 mm thickness is placed on top and covered with the same quantity of green mixture. Thereafter, a pressure of 2 metric tons per cm^2 is applied for molding the laminated body.

The pressed bodies are inserted into crucibles and fired in a gas-heated chamber furnace at a temperature up to 900°C . Thereafter, a graphitizing treatment is applied by subjecting the fired body to a maximum temperature of 2800°C . The resistivity in the pressing direction, i.e. perpendicular to the plane of the embedded web, was measured as $290 \text{ ohm mm}^2/\text{m}$. The resistivity parallel to the web was $50 \text{ ohm mm}^2/\text{m}$ giving a ratio of longitudinal to transverse resistivity of 5.8.

EXAMPLE 2

The green mixture of Example 1 is pressed in a mold as described, except that two layers of carbonized fiber are employed in the form of webs made of fine threads and having a thickness of 0.2 mm. For this purpose, one third of the total quantity of green mixture is placed into the press mold and then covered with the first web layer. Thereafter, the second third of the green mixture quantity is placed in the mold. After the second web is put on top, the remaining third of the mixture quantity is filled in. To improve bonding, the webs are sprayed with furfuryl alcohol prior to placing them into the mold. The further fabrication is in accordance with Example 1. The electrical resistivity of the graphitized brushes was measured as:

In the direction of the webs $42 \text{ ohm mm}^2/\text{m}$
Perpendicular to the webs $255 \text{ ohm mm}^2/\text{m}$

This corresponds to a 6.1 ratio of transverse to longitudinal resistivity.

EXAMPLE 3

A petrol-coke mixture bonded to tar-pitch is filled up to a height of 25 mm into a mold of $100 \times 150 \text{ mm}$ cross section. The mixture is covered with a partially carbonised wool fabric (largely dehydrated by chemical and thermal treatment up to 300°C). Ultimately, a second layer of the green mixture is filled into the mold, up to an additional height of 25 mm. Then the body is pressed, fired and graphitized as described in Example 1.

The brushes were found to have the following resistivity values:

In the web direction $19 \text{ ohm mm}^2/\text{m}$
Perpendicularly to the webs $97 \text{ ohm mm}^2/\text{m}$
Ratio of longitudinal to transverse resistivity of 5.1

WHAT WE CLAIM IS:—

1. A commutator brush of high transverse-to-longitudinal resistance ratio, comprising a body of carbon bulk material and at least one layer of mesh material formed of carbonised fiber embedded within said body material and extending longitudinally thereof.
2. A commutator brush according to Claim 1, wherein the layer consists of carbonised fiber material.
3. A commutator brush according to Claim 2, wherein the layer consists of a woven web of carbonized animal fiber.
4. A commutator brush according to any one of Claims 1 to 3 wherein the layer of carbonised fiber has been graphitized.
5. A commutator brush according to any one of Claims 1 to 4, comprising a plurality of the mesh layers extending parallel and equidistant relative to each other.
6. A commutator brush according to any one of Claims 2 to 5, comprising two said woven layers of carbonized fiber parallel to each other and spaced each from the other approximately the same distance as from the nearest parallel side of said body.
7. A method of producing a commutator brush of high transverse-to-longitudinal resistance ratio which comprises filling a green mass of industrial carbon into a mold and embedding in the mass at least one layer of mesh material formed of a carbonaceous substance, compressing the green mass together with the embedded layer in the mold to the shape of the brush, and carbonizing the mesh layer within the shaped body.
8. The method according to claim 7, wherein said layer of mesh material is carbonized prior to embedment, and is subsequently graphitized within the shaped body.
9. The method according to claim 7, which comprises embedding said layer in the form of woven animal fiber material which is incompletely carbonized.
10. The method according to claim 7, which comprises impregnating said layer with binding agent before embedding said layer in said green mass.
11. The method according to any one of claims 7 to 10, which comprises moistening said layer with furfuryl alcohol before embedding said layer in said green mass.

12. A commutator brush of high transverse-to-longitudinal resistance ratio, substantially as described in any one of the foregoing Examples.
- 5 13. A method of producing a commutator brush of high transverse-to-longitudinal resistance ratio, substantially as described in any one of the foregoing Examples.

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1 SHEET

COMPLETE SPECIFICATION

*This drawing is a reproduction of
the Original on a reduced scale.*

